VOLUME 1

FINAL CORRECTIVE MEASURES STUDY
RMI SODIUM PLANT
ASHTABULA, OHIO

OHD 000 810 242
March 1993
Revised September 1994
Revised May 1995

Prepared for:

RMI Titanium Company
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May 12, 1995

Mr. Thomas W. Matheson
HRP-8J
Corrective Action Project Manager
Ohio Permitting Section
U.S. EPA, Region 5
77 W. Jackson Blvd.
Chicago, IL 60604-3590

Re: Responses to Comments on CMS Report
RMI Sodium Plant OHD 000 810 242

Dear Mr. Matheson:

Enclosed are RMI's responses to the U.S. EPA comments of March 3, 1995 on the Corrective Measures Study (CMS) and the revised CMS Report. In addition to revisions based on comments, Section 7.0 PROJECT SCHEDULE of the CMS has been updated.

RMI has been proactive in our attempts to move the RCRA corrective action process along at this site. The original CMS was delivered to U.S. EPA in August 1991. It is disturbing after two previous U.S. EPA reviews to now receive 66 comments, many of which are regarding issues which have previously been raised, discussed, and resolved, or are based upon previously approved documents, all dating back to 1990, or to receive review comments which bring new issues which could have been raised previously. For example, review and consideration of the comments reveals that:

- general comment 1 and specific comment 57 express U.S. EPA's and Ohio EPA's reservations regarding the proposed corrective measure; this is the first time this measure has been questioned, and these reservations are now expressed after U.S. EPA indicated a general concurrence with the measure through lack of comment on previous versions of the CMS and at several meetings, most recently on July 28, 1994 in Chicago;

- 25 of the comments (nearly 38 percent) concern the summary of the previously approved RFI and Supplemental RFI reports (general comment 2 and specific comments 1, 2, 3, 5, 6, 7, 8, 9, 11, 12, 16, 17, 18, 21, 23, 27, 29, 31, 37, 39, 40, 41, 43, and 45); this may

have occurred because, as we learned during our conference call on March 2, not all of the reviewers had received copies of the RFI documents;

- 8 of the comments pertain to the wording of the description of the shallow groundwater zone beneath the site, which appears throughout the document (specific comments 4, 13, 15, 19, 20, 28, 30, and 42); the CMS Report has been revised accordingly;

- 16 of the comments are concerned with typographical or other minor corrections (general comment 3 and specific comments 10, 22, 24, 26, 34, 35, 44, 47, 48, 50, 51, 52, 54, 55, and 56);

- 9 of the comments are new thoughts of U.S. EPA and/or Ohio EPA about the CMS Report (specific comments 14, 25, 32, 33, 36, 38, 49, 53, and 59); and

- only 6 of the comments are in response to the CMS Report revisions provided to U.S. EPA in September 1994 for the issues which were raised by U.S. EPA in June 1994 (specific comments 46, 58, 60, 61, 62, and 63).

This submittal represents a substantial effort by RMI and its consultants to be fully responsive to your most recent set of comments. We would like to meet with you soon after your review so that we can attempt to resolve any remaining issues where our opinions differ from yours. Please call so that we can schedule a meeting in the near future, 216/544-7688.

Sincerely,

Richard L. Mason
Director
Environmental Affairs

sim

enclosure

c (w/e): Adriene LaFavre, OEPA - 2 copies
Edwin Lim, OEPA - 2 copies

c (wo/e): Jeffrey L. Pintenich - Eckenfelder

TABLE OF CONTENTS

VOLUME 1

TABLE OF CONTENTS (Continued)

TABLE OF CONTENTS (Continued)

TABLE OF CONTENTS (Continued)

TABLE OF CONTENTS (Continued)

TABLE OF CONTENTS (Continued)

TABLE OF CONTENTS (Continued)

TABLE OF CONTENTS (Continued)

LIST OF TABLES

LIST OF TABLES (Continued)

LIST OF TABLES (Continued)

LIST OF TABLES (Continued)

LIST OF FIGURES

EXECUTIVE SUMMARY

The RMI Titanium Company Sodium facility received a final RCRA hazardous waste management operating permit from the USEPA Region V in 1987. Included in this permit was the requirement for RMI to conduct a RCRA Facility Investigation (RFI) in which the nature and extent, if any, of releases from previous and existing solid waste management units (SWMUs) at the facility would be determined. The following documents have been generated as a result of this requirement and have led to the preparation of this revised Final Corrective Measures Study (CMS) report:

- Draft RFI Report (May 1989)
- Revised RFI Report (June 1990)
- Draft CMS - Partial Submittal (June 1990)
- Draft Supplemental Investigation Report (April 1991)
- Draft CMS Plan (May 1991)
- Revised Supplemental Investigation Report (August 1991)
- Revised CMS Plan (August 1991)
- Draft CMS Report (August 1991)
- Revised CMS Plan (March 1993)
- Final CMS Report (March 1993)
- Baseline Risk Assessment - Appended to this revised Final CMS Report (September 1994)

The RFI indicated that there were two water-bearing zones at the RMI site - a shallow groundwater zone within the fill and glacial till and a deep, bedrock zone. The RFI concluded that the shallow groundwater had been affected by RMI activities and identified Ba and Cd as constituents of interest, although at relatively low concentrations. In addition, the shallow groundwater was characterized by a low hydraulic conductivity and a yield below that required by an average size household and, therefore, is not expected to serve as a source of drinking water. It further concluded that the deep groundwater zone had not been affected by plant activities. Soils were also investigated during the RFI and were found to exhibit levels of As, Cd, and Pb at levels statistically above background concentrations in the surficial and shallow soils. Off site migration of the constituents of interest via surface water was investigated and found to not be a concern.

The Supplemental Investigation was performed to further characterize the groundwater and surface water and sediments and focused on the eastern property boundary. The conclusions made in the Supplemental Investigation report generally confirmed those made in the Revised RFI report.

The Draft CMS - Partial Submittal included a Health and Environmental Assessment (HEA) of the RMI facility. The HEA concluded that the pathway of concern included erosion of surficial soils to on site ditches. However, the HEA further concluded that the potential risks were within acceptable levels and that there was no substantial human health or environmental concern. Action levels were developed by the USEPA and presented in the Draft CMS - Partial Submittal. These action levels were briefly discussed with respect to the site and a preliminary plan regarding how they would be addressed by the final CMS was also provided. The comparison of USEPA action levels to constituent concentrations detected at the RMI site for various media indicated that a CMS was necessary.

In the development of a logical approach to the CMS, the Revised RFI, the Supplemental Investigation, the HEA, and the USEPA action levels were discussed in the CMS Plan. The CMS Plan, developed pursuant to the Scope of Work issued by the USEPA, set forth the manner in which the action levels and site areas would be addressed. Considering the findings and conclusions of previous studies and existing site conditions, the CMS Plan established a relatively straightforward approach to the development of appropriate corrective measures.

Additionally, the approach to the CMS was further refined based on the June 13, 1994 comments from the USEPA on the draft final CMS report. The USEPA expressed the desire for a full quantitative human health risk assessment to be performed for soils at the RMI Sodium Plant. The details of this assessment were confirmed at a July 28, 1994 meeting between USEPA, RMI, and ECKENFELDER INC.® As discussed at this meeting, there are currently no final regulations that require this level of risk analysis for an RFI/CMS, but the USEPA felt it was necessary, based on their unpublished directives regarding "environmental justice".

The risk assessment conducted at the request of the USEPA consisted of a full quantitative human health risk assessment and was performed for soils for the

constituents, depths, and areas of interest at the RMI Sodium Plant. The areas and constituents of interest are a result of a comparison of site soil data to background levels during the RFI, as well as a comparison to USEPA action levels for the site. Potential receptor populations under both current and future scenarios were considered. Since the facility is located in a highly industrialized area and site access is restricted by means of a chain-link fence and 24 hour-a-day security guards, only the industrial worker population was evaluated under the current scenario. Two future scenarios for the site were considered: (1) conditions remain essentially the same as the current situation (i.e., the site remains industrial), and (2) the site undergoes residential development. Although RMI considers future residential development of the site to be unlikely, the USEPA required that it be evaluated. Therefore, under the future scenario, both residential and industrial populations were assumed.

Risk estimates were calculated for the potential current and future receptor populations evaluated. Carcinogenic and noncarcinogenic risks were calculated separately for each of four of the five areas of interest at the RMI Sodium Plant (Areas B, C, F, and G), as well as for Areas B and C combined (as the areas were combined in the draft final CMS report), and for background soils. Risks were not quantified for Area D since no toxicity data are currently available for lead, the only constituent of interest in Area D. However, with USEPA concurrence, concentrations of lead in soil in all of the areas of interest were compared to the CERCLA/RCRA lead screening level for residential soils of 400 ppm. Only one soil sample exceeded this level (SS3-3 from Area B surficial soils). Considering all of the total estimated carcinogenic risks for both the current and future scenarios, including risk estimates for background soil, none of the total estimated carcinogenic risks for either the current or future scenarios exceeded the upper limit of USEPA's acceptable range (1×10^{-4}). Two future noncarcinogenic hazard indices exceeded USEPA's acceptable limit of 1.0: potential residential exposure to surficial soils from Area B and potential residential exposure to surficial soils from Areas B and C combined. (Note: the combined area exceeded the limit because Area B exceeded the limit). With the exceptions of these two risk estimates, all of the remaining total noncarcinogenic hazard indices were below USEPA's acceptable level of 1.0.

The risk estimates for the SWMUs should also be considered in conjunction with those calculated for the background soils. First, it is clear that the background risk

estimates present the absolute lower performance bound of any possible cleanup activities at the site, and thus cleanup to a one in one million (1×10^{-6}) risk level would be impossible. Second, with the exception of the hazard indices for Area B, all of the potential risks are very close to background conditions, and corrective measure for the other SWMUs would offer only marginal enhancement of protection of human health. Finally, the only risk estimates which exceed USEPA's acceptable values are for a speculative future residential development on a long-standing industrial property, and therefore, from the perspective of protecting human health, there are no compelling reasons to undertake any sort of corrective measures for soils in SWMUs at the RMI Sodium Plant.

The universe of remedial technologies was screened in the CMS based upon the requirement of meeting corrective measure objectives. The result of this screening was the assembly of ten corrective measure alternatives. The CMS used a variety of regulatory criteria to evaluate each of these alternatives. Based upon this evaluation, a corrective measure alternative consisting of excavation of Areas B, C, and G; on site disposal at Area A; and No Further Action at Areas D, E, and Area F is recommended for implementation. This alternative was determined to be protective of human health and the environment and meet all corrective action objectives. The alternative is reliable, effective, and safe and provides reduced constituent mobility, consolidation of affected material, and placement on site which allows close control by RMI.

The general vicinity around Area A has been proposed by RMI for designation as a CAMU. Designation of the area around Area A as a CAMU meets the regulatory requirements of 40 CFR 264.552 and will allow the flexibility necessary to expeditiously implement the recommended alternative.

Lastly, a schedule for implementation of the recommended alternative has been proposed in the CMS. The schedule is indicative of the fact that there are relatively limited environmental concerns at the site and that the alternative can be implemented expeditiously. Compliance with the proposed schedule would likely provide for the implementation and final approval (following implementation) of the selected corrective measure alternative by November 1996.

1.0 INTRODUCTION

1.1 OVERVIEW

Until 1991 RMI Titanium Company (RMI) operated a sodium manufacturing facility in Ashtabula, Ohio for the manufacture of pure elemental sodium using the electrolytic cell process. In 1986, the USEPA and the Ohio EPA made a tentative determination that a release of hazardous constituents to the environment at the RMI facility had occurred from units other than the active hazardous waste management facilities. In early 1987, the Sodium Plant received a final Resource Conservation and Recovery Act (RCRA) hazardous waste management operating permit from the USEPA Region V. This permit allows RMI to continue to store and treat hazardous waste at the facility.

In the Sodium Plant RCRA permit, RMI was required by USEPA to prepare a Work Plan for, and to conduct, a RCRA Facility Investigation (RFI). The objective of the RFI was to determine the nature and extent of releases, if any, from previous and existing solid waste management units (SWMUs) at the plant. The RFI Work Plan was prepared by RMI's consultants, ECKENFELDER INC.® (formerly AWARE Incorporated), and submitted to the Agencies in June 1987. In late March 1988, USEPA approved the Work Plan (with minor modifications) and directed RMI to proceed with the RFI. Each of the RFI Work Plan tasks were performed by ECKENFELDER INC.® using the guidelines presented in USEPA's Interim Final RCRA Corrective Action Plan (June 1988), the draft RCRA Facility Investigation (RFI) Guidance Document (July 1987), and in accordance with USEPA's 3004(u) policy.

The RFI report was submitted to the USEPA in May 1989. The USEPA prepared formal comments on the RFI report and transmitted these comments to RMI in a letter dated April 1990. In May 1990, a meeting was held in USEPA's RCRA branch office to discuss the USEPA's comments on the RFI. Representatives from the USEPA, Metcalf & Eddy, Inc. (USEPA's consultant), RMI, and ECKENFELDER INC.® attended the meeting. Comments by USEPA were discussed and several technical issues were resolved, as follows:

- The organics which are present in environmental media at the RMI Sodium Plant site are the result of the migration of organic constituents from off site sources, not a result of activities at the RMI Sodium Plant, and that RMI would not be required to consider remediation for the organics on site.

- It was acknowledged that the barium (Ba) concentrations measured in the bedrock groundwater zone at the project site are not a result of activities at the RMI Sodium Plant and are naturally occurring.

- It was acknowledged that RFI action levels for environmental media are to be used only to determine whether or not a Corrective Measures Study (CMS) needs to be conducted at the site. Furthermore, the action levels do not automatically set a precedent for clean up levels at the site, and clean up levels are relevant to the evaluation of remedial alternatives during the CMS.

- It was agreed that a CMS report would be prepared for the RMI Sodium Plant to address those areas and media at the site which exceed action levels or have been identified in the RFI report as being of potential concern.

It was also agreed during this meeting (and subsequently confirmed by a letter from the USEPA to RMI) that a formal response to USEPA's comments would be submitted to the USEPA by RMI in June 1990 and would include a discussion of additional work proposed for the site. In addition, it was determined that Task IA (description of the current situation) of the CMS Scope of Work given in USEPA's April 1990 comments and a plan for completing Task IB (establishment of Corrective Action Objectives) would be prepared and submitted to the USEPA in June 1990. As discussed during the May 9, 1990 meeting, the Health and Environmental Assessment (HEA, previously Section 7 of the RFI report) would be revised and included in the June submittal as part of the CMS tasks and would be removed from the RFI report. Sections 1 through 6 of the RFI report were revised per USEPA's comments and discussions from the May 1990 meeting, and submitted to the USEPA in June 1990 as the Revised RFI report. In June 1990, a draft report representing a partial submittal of the draft CMS report was also submitted to the

USEPA. This partial submittal included the execution of Task IA, revisions to the HEA, and the plan for executing Task IB (establishment of Corrective Action Objectives), as discussed above.

The description of the supplemental work to be performed at the site was given in RMI's written response to the USEPA comments submitted in June 1990, and the tasks are also described in the Revised RFI report. A Supplemental Work Plan (ECKENFELDER INC.®, October 1990) was prepared, submitted to the USEPA in October 1990 and was subsequently revised in response to comments issued by the USEPA in December 1990. The revised Supplemental Work Plan was submitted to the USEPA in January 1991 and was approved by the USEPA in February 1991.

The objectives of the supplemental investigation were to: evaluate the integrity of the acid tank; define the bedrock piezometric surface and direction of groundwater flow; determine the hydrogeology and shallow groundwater, surface water, and sediment quality in the vicinity of the plant's eastern property boundary; determine the potential for off site contaminant releases adjacent to the eastern property boundary; and to define sediment quality in an on site ditch where erosion of soil or fill materials had been documented. The supplemental work plan tasks were performed by ECKENFELDER INC.® in accordance with the procedures described in the "Work Plan for RCRA Facility Investigation, RMI Sodium Plant, Ashtabula, Ohio" (ECKENFELDER INC.®, June 1987) and the "Interim Report, RCRA Facility Investigation, RMI Sodium Plant, Ashtabula, Ohio" (ECKENFELDER INC.®, July 1988). The Quality Assurance Project Plan (QAPP) was included in the original work plan and the Health and Safety Plan (HSP) was revised and included in the supplemental work plan.

The supplemental investigation report summarizes the results of the supplemental investigation for the RFI, and was submitted to the USEPA for review in April 1991. Included in this report are the following:

- A discussion of the field methodologies used during the supplemental investigation.

- A discussion of the bedrock groundwater conditions.

- A characterization of the eastern boundary of the Sodium Plant property, including groundwater and surface water conditions, and groundwater, surface water, and sediment quality.

- A characterization of sediment quality in the vicinity of previous surface water sample SW-B.

- A comparison of media quality to USEPA-derived action levels.

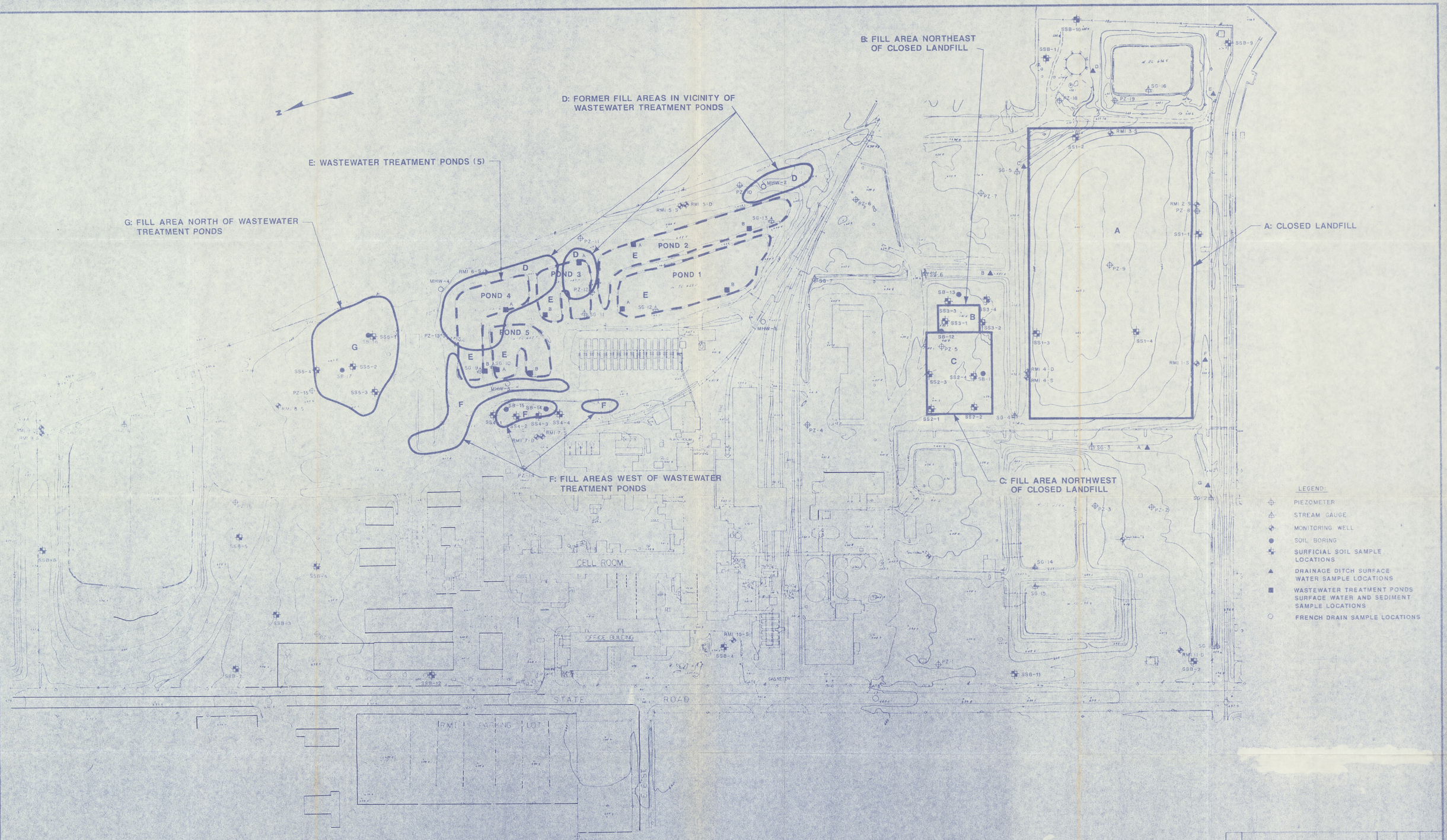
RMI determined that it would be a convenient time to install plastic liners in the acid tanks while they are empty for inspection. Therefore, the acid tank integrity test was postponed while the need for liners was evaluated. RMI is preparing a separate report on the acid tank inspection.

1.2 SUMMARY OF RFI FINDINGS AND DESCRIPTION OF CURRENT SITE SITUATION

The Revised RFI report for the RMI Sodium Plant was submitted to the USEPA on June 29, 1990. The Revised RFI report should be consulted for more detailed information regarding the current site situation.

RMI's RCRA hazardous waste management operating permit for the Sodium Plant identifies five SWMUs. However, subsequent revisions identified ten SWMUs at the site. Of the ten previous and active SWMUs identified, seven were included in the RFI Work Plan approved by USEPA (see Figure 1-1). These seven SWMUs are the closed landfill (Area A), the area northeast of the closed landfill (Area B), the area northwest of the closed landfill (Area C), the former fill areas in the vicinity of the wastewater treatment ponds (Area D), the wastewater treatment ponds (Area E), the fill areas west of the wastewater treatment ponds (Area F), and the fill area north of the wastewater treatment ponds (Area G).

Materials that have been deposited at the plant property include cell bath waste, anode butts, and miscellaneous solid waste including electrolytic cell construction materials and salt dissolver sludge. The principal constituents associated with the site are barium (Ba), cadmium (Cd), and lead (Pb).



ECKENFELDER INC. Nashville, Tennessee / Edison, New Jersey

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RMI SODIUM PLANT
Ashtabula, Ohio

FIGURE 1-1
SWMU AND MEDIA SAMPLING LOCATIONS

SCALE: 1" = 100'

DRAWN BY: CASE: 8/91 | CHECKED BY: | APPROVED BY:

DRAWING NUMBER: 6497

1.2.1 Summary of Field Work

The Scope of Work for the RFI field investigation was described in detail in the approved "Work Plan for RCRA Facility Investigation, RMI Sodium Plant, Ashtabula, Ohio" (ECKENFELDER INC.®, June 1987). The Scope of Work was subsequently updated during the RFI field investigation and was described in the "Interim Report, RCRA Facility Investigation, RMI Sodium Plant, Ashtabula, Ohio" (ECKENFELDER INC.®, July 1988).

The first RFI work task consisted of the compilation and review of existing information with respect to the project site. This included historical aerial photographs, topographic maps, and reports. Historical aerial photographs of the RMI Sodium Plant were reviewed in order to locate solid waste management units (SWMUs) and their approximate periods of operation. In addition, the aerial photographs were reviewed to determine past surface water drainage patterns and land uses of the site and surrounding areas. A site topographic map for the project area was obtained from RMI Company. This map was used to provide a consistent data base and depicts topography with 2 feet contour intervals and shows major site features including monitoring wells, boring locations, ponds, drainage ditches, roads, etc. Additionally, the elevations of all piezometers, monitoring wells, and staff gauges were measured by a licensed surveyor.

A surface geophysical survey was conducted over four primary areas of known or suspected waste disposal activities at the RMI plant site. The survey was employed to define the areas of past waste disposal, and possibly, their effects on groundwater and soil conditions. The geophysical survey utilized both terrain conductivity and earth resistivity methods.

Surficial soil sampling was conducted in five areas of the RMI Sodium Plant: the fill area north of the wastewater treatment ponds (Area G), the fill area west of the wastewater treatment ponds (Area F), the area northeast of the closed landfill (Area B), the area northwest of the closed landfill (Area C), and the closed landfill (Area A). Four surficial soil samples were collected at each location; 12 background samples were also collected. The results of the surficial soil analyses were evaluated for statistical significance relative to background concentrations, per the request of USEPA.

Twenty piezometers were installed at key locations throughout the site to provide a definition of groundwater flow patterns. Data obtained from the piezometers were used to identify locations of soil borings and monitoring wells. Eighteen soil borings were advanced to recover soil at various depths at locations of indicated past waste disposal, adjacent to such waste disposal areas, or in background areas. Soil borings were either converted to shallow monitoring wells, deep bedrock monitoring wells, or grouted to land surface. Some soil samples collected from the borings were analyzed for various parameters.

Ten shallow monitoring wells were installed to provide information on the water table surface and the water quality in the glacial till water-bearing zone. Five deep monitoring wells were installed to provide information on the piezometric surface and the water quality in the bedrock water-bearing zone. Water level measurements and in situ hydraulic conductivity tests were utilized to determine groundwater flow regimes at the site. Groundwater was sampled and analyzed during two episodes from each monitoring well.

Water samples were collected from the wastewater treatment ponds, french drains, and the drainage ditches. Sediment samples were also collected from the ponds. These samples were analyzed for various chemical parameters.

The locations of all media sampled during the RFI were given in Figure 1-1.

1.2.2 Conclusions of the Investigation

Site geologic conditions were determined to correlate quite well with regional reports. Three hydrostratigraphic units have been observed beneath the RMI site:

1. An unconfined water table zone exists within the fill and weathered glacial till with presumed moderate hydraulic conductivity. In general, the groundwater is mounded around the ponds at the site and the overall groundwater flow directions radiate outward from the site; and

2. A semi-confining unit comprised of the unweathered glacial till. This unit is of presumed lower hydraulic conductivity and separates the shallow water table zone and the lower bedrock water-bearing unit.

3. A semi-confined water-bearing zone within the lower hydraulic conductivity shale. Based upon limited piezometric surface data and, consistent with the geologic literature, the horizontal flow of groundwater in the shale is toward the north to Lake Erie.

In the RFI report it was demonstrated that the shallow water-bearing zone in the vicinity of the RMI Sodium Plant is characterized by low yield and, therefore, groundwater in this water-bearing zone is not expected to serve as a drinking water source. This was later supported by the HEA, where it was noted that there are currently no potential human receptors of shallow groundwater, no reasonable future receptors, and there is an abundance of surface water for use as a drinking water source.

On site surface water drainage patterns indicate that a runoff divide exists within the main process area of the plant site. Water falling south of the divide will generally be intercepted by ditches which flow to the west and south, discharging into the DS Tributary of Fields Brook. Water falling north of the divide will flow off site to the north and, presumably, ultimately into Lake Erie.

Constituents present in the environmental media on the RMI site are interrelated through a variety of potential release mechanisms and migration pathways. These potential release mechanisms and migration pathways will be further addressed in the revised HEA section of this report (Section 2). The findings and explanations for the presence of site constituents in the media sampled at the RMI site are briefly described in the following paragraphs.

1.2.2.1 Air. No measurements of total organic vapors and gases in ambient air above background levels were observed during field activities, with the exception of observed HNU readings in the vicinity of the borehole during drilling of PZ-9 (at 19 feet) and PZ-8 (at 10 feet), and in the soil headspace HNU readings of soils collected from borings 1S and 2S. These borings are all located in the vicinity of the southern property boundary where a dense non-aqueous phase liquid (DNAPL)

originating off the site was detected. The detection of the DNAPL is further discussed in this section under **Off Site Source(s)**. Although no air monitoring has been conducted for metals, it is possible that trace quantities of metals sorbed onto the surficial soils may migrate via fugitive dust.

1.2.2.2 Groundwater. Elevated (with respect to background conditions) concentrations of Ba and Cd in shallow groundwater have been detected on site, particularly in the areas north (Area G) and east of the wastewater treatment ponds (Area D). The highest concentration of Ba detected in groundwater was 1,900 ppb, in well 8-S near Area G; the highest concentration of Cd was 25.7 ppb, in well 6-S near Area D. The presence of these constituents in groundwater is believed to be due, in part, to recharge of the groundwater from the wastewater treatment ponds, and from the leaching of subsurface soils or buried wastes.

The direction of contaminant migration in shallow groundwater appears to radiate outward from the site. The shallow groundwater ultimately discharges to the DS tributary of Fields Brook in the vicinity of the closed landfill, and to the drainage ditch east of the five ponds. However, because the drainage ditches are shallow and do not intercept the entire water table zone, contributions of constituents from shallow groundwater to surface water ditches are expected to be minimal. The rate of Ba and Cd migration in the shallow groundwater is believed to be controlled by a combination of several factors including speciation, dissolution/precipitation, and sorption; however, the relative significance of these factors is not well defined. Additional discussion appears in Section 5.3.3 of the approved RFI report.

The concentrations of metals measured in the shale groundwater zone are at background levels. Barium was the only metal consistently detected in the bedrock groundwater wells and it occurred at concentrations greater than the shallow groundwater background values. However, the presence of Ba in the deep bedrock groundwater does not necessarily indicate a connection with the SWMUs on site. Based upon the low permeability and considerable thickness of the unweathered glacial till, and the relatively small hydraulic gradient between the bedrock and the shallow aquifer, it is apparent that only a minimal downward component of flow exists between the two water bearing zones.

Major ion data also demonstrate that the bedrock groundwater has a distinctively different chemistry than the shallow groundwater. Barium/chloride ratios in the bedrock and shallow aquifers support the hypothesis that the deep groundwater has not been impacted by the shallow groundwater. Because chloride is a very conservative ion (i.e., is not readily attenuated), chloride would migrate along a downward vertical gradient at a greater rate than barium, which may be attenuated more readily than the chloride ion. The average barium concentration in deep and shallow groundwater is 7.2 ppm and 0.76 ppm, respectively, while average chloride concentration in the deep and shallow groundwater is 10,388 ppm and 19,000 ppm, respectively. These concentrations demonstrate that an inverted ratio between the barium and chloride concentrations in the deep and shallow groundwater exists at the site. The inverted ratio indicates that the barium in the deeper groundwater could not have originated from the shallow groundwater aquifer on site. In addition, the Ohio Department of Natural Resources publication "Characterization of Trace Metals in Ohio Brines" (Open File Report 89-1, 1989) shows that barium concentrations in the Chagrin Shale in southern Ohio range from 8.0 ppm to 82 ppm. These concentrations are similar to or higher than those in the Chagrin Shale at the RMI site supporting the conclusion that these levels of barium are consistent with those that occur naturally. The barium concentrations in the deep wells on the RMI Sodium Plant site range from approximately 1,100 µg/L to 18,000 µg/L with only one deep well having concentrations above 9,000 µg/L. Barium concentrations in deep wells on other sites within the Fields Brook watershed range from approximately 100 µg/L to 8,600 µg/L. These data support the conclusion that water quality in the bedrock aquifer has not been impacted by SWMUs on the site, especially when coupled with hydrogeological data showing that the bedrock aquifer is separated from shallow groundwater by the low-permeability unweathered glacial till and that the hydraulic gradient across the unweathered glacial till is very small.

An exception to the above is the barium/chloride ratio observed for wells 9-S and 9-D. The chloride concentration in well 9-S (70 ppm) is much less than that in 9-D (11,900 ppm), and also much less than those measured in the other shallow wells, due to the localized influence of recharge from the Ashco water supply reservoir. The Ashco water supply reservoir is an unlined reservoir located approximately 50 feet from well 9-S. The water level within the reservoir is maintained at an elevation approximately 5 feet higher than that observed in well 9-S (see

Figure 4-11, Revised RFI), resulting in a substantial hydraulic gradient and associated groundwater flow from the reservoir into the shallow water-bearing unit and toward 9-S. The source of water for the reservoir is Lake Erie, a fresh water supply with a low chloride concentration, similar to that observed in 9-S. Notably, calcium, manganese, sodium, and potassium concentrations in 9-S are also consistently lower than those observed elsewhere in shallow groundwater on the RMI site, further supporting the conclusion that shallow groundwater quality is locally influenced by the Ashco water supply reservoir.

1.2.2.3 Soils. Both surficial and subsurface soils were collected at various locations on the RMI plant site. Surficial soil samples were analyzed for nine inorganic parameters. A statistical test (Student's t test) was applied to the surficial soil data to assess the significance of the differences in means found between samples from background and test areas. Compared to background concentrations, Ba, Cd, Pb, nickel (Ni) and arsenic (As) in Area B; Ba, Pb, and selenium (Se) in Area C; Ba, Cd, Pb, Ni, and As in Area F; and Ba, Cd, chromium (Cr), Ni, and As in Area G were determined to be present in surficial soils at elevated concentrations. A priority pollutant scan was also conducted on one sample. No volatile organic, acid extractable, or base neutral compounds, pesticides, PCBs, phenols, or cyanide were detected.

Subsurface soil samples were analyzed for nine inorganic parameters as well as total cyanide. The subsurface soils which showed elevated concentrations (with respect to background) were determined to be: Area D, between 3.0 and 6.5 feet for Ba, Pb, and Ni; and Area G for Pb, Cd, and Ni at depths less 6.5 feet. When comparing subsurface soil data with surficial soil data, it is apparent that the SWMUs in the vicinity of the ponds (Areas D, F, and G) were used as fill areas and the SWMUs in the vicinity of the closed landfill (Areas B and C) were used as temporary surficial storage zones for material that was later placed into the landfill. Priority pollutant scans were conducted on three samples. Volatile organic, base neutral, and acid extractable compounds were detected only in the vicinity of the Dense Non-Aqueous Phase Liquid (DNAPL), which originates from an off site source (further discussed below). Two samples exceeded the EP Toxicity Equivalent for lead and cadmium (the respective Maximum Contaminant Level multiplied by 20, which was used to screen samples for EP Toxicity testing). However, when EP

Toxicity tests were performed on these samples, it was determined that they were not EP Toxic for cadmium or lead.

1.2.2.4 Surface Water. Samples were collected from the wastewater treatment ponds, the french drain system, and the site drainage ditches. Barium and Cd were found in all of the ponds, with Ba in the highest concentrations in both the pond water (at 5,500 ppb in Pond 3) and pond sediments (3,020 ppm in Pond 4). Barium appeared to be the only parameter detected in the pond sediments at elevated concentrations. The concentrations of constituents in the french drain samples were substantially lower than the pond water samples, with Cd at 26.8 ppb in Manhole 5 being the highest constituent level detected. No Ba was detected in samples from the french drain system (please note that the appropriate detection limit for Ba was higher than for other metals and was used throughout the study). Very low concentrations were found for most constituents in the ditch samples; the highest levels detected were: zinc (Zn) at 359 ppb at DW-E (and at 77 ppb at DW-G) and Cd, at 37.9 ppb at location DW-B. Because of the location of DW-E (the southeast corner of the property, where the ditch originates from off site), it is believed that the Zn could be attributed to an off site source to the east. The concentration of Cd at location DW-B is believed to be the result of the presence of suspended sediment in the water sample which likely originated from the erosion of surficial soils from Area B. Although the presence of organics was indicated from the results of priority pollutant scans (conducted on samples DW-E and DW-G), the presence of organics is believed to be due to sources originating off site.

1.2.2.5 Off Site Source(s). A dense non-aqueous phase liquid (DNAPL) comprised of chlorinated solvents and associated dissolved constituents found on the RMI site is believed to be the result of an off site source located to the south. This conclusion is based on the fact that RMI does not and has never used chlorinated solvents at the Sodium Plant. This is supported by the observation that the major portion of the sandy till zone, which contains the DNAPL, occurs to the south of the RMI site, and the piezometric surface of the DNAPL-saturated sandy till has not been observed anywhere except the extreme southern boundary of the RMI site. In addition, dissolved organic constituents from the DNAPL have only been observed in the immediate vicinity of the southern boundary of the RMI property. A chemical manufacturing facility, located on the southern border of the site, has historically discharged chlorinated solvents to Fields Brook and unlined settling lagoons on

their property. This is supported by the report "Fields Brook Source Control Operable Unit Remedial Investigation Report" (Woodward-Clyde, 1992), which addresses those potential sources. Therefore, sufficient information has been collected to conclude that the DNAPL source is off site to the south.

1.2.3 Recommendations of the RFI Report

Based upon results of the RFI, it was recommended that supplemental investigations be undertaken at the RMI Sodium Plant site. These further investigations included the following:

- Acid (Neutralization) Tank Integrity Testing
- Deep Well Water Levels
- Eastern Boundary Characterization
- Temporary Piezometer Abandonment
- Preparation of Supplemental Investigation Report

1.3 SUMMARY OF SUPPLEMENTAL INVESTIGATION FINDINGS

A supplemental investigation to the RFI was performed by ECKENFELDER INC.® in February 1991 in accordance with the recommendations of the RFI. The results of the investigation were submitted in the "Supplemental Investigation Report for the RCRA Facility Investigation, RMI Sodium Plant, Ashtabula, Ohio" (ECKENFELDER INC.®, April 1991). The elements included in this report are as follows:

- A discussion of the field methodologies used during the supplemental investigation.

- A discussion of the bedrock groundwater conditions.

- A characterization of the eastern boundary of the Sodium Plant property, including groundwater and surface water conditions, and groundwater, surface water, and sediment quality.

- A characterization of sediment quality in the vicinity of previous surface water sample SW-B.

- A comparison of media quality to USEPA-derived action levels.

Results of the acid tank integrity test will be submitted separately by RMI to the USEPA.

1.3.1 Summary of the Supplemental Investigation Field Work

The Scope of Work for the supplemental field investigation is described in the "Supplemental Investigation Report for the RCRA Facility Investigation Report" (ECKENFELDER INC.®, April 1991) and is summarized below.

Three piezometers were installed in the vicinity of the eastern boundary of the Sodium Plant to provide a better definition of shallow groundwater flow between the five wastewater treatment ponds and the off-site coal pile (see Figure 5-1). The newly installed piezometers and 14 of the original 20 piezometers were abandoned following a series of complete water level measurements; the piezometers were abandoned by grouting to land surface.

Three shallow wells were installed; one well (8-SR) was a replacement monitoring well for the previously abandoned well 8-S and two wells (12-S and 13-S) were installed to provide information on the occurrence and quality of groundwater in the glacial till water-bearing zone in the vicinity of the eastern property boundary. The replacement monitoring well was drilled to a depth of 14 feet, while the two shallow wells on the eastern boundary were drilled to depths of 14 and 15 feet. The locations of these wells are presented on Figure 5-1.

All existing and newly installed monitoring wells were sampled, with the exception of wells 1-S and 2-S, which are known to contain a dense non-aqueous phase liquid (DNAPL) which migrates from off the RMI property. Well 8-SR also was not sampled because of failure to recharge with groundwater. All monitoring well samples were analyzed for As, Ba, Cd, Cr, copper (Cu), Pb, mercury (Hg), Ni, Se, silver (Ag), Zn, and cyanide (CN); and all groundwater samples were analyzed for

both dissolved and total metals. Due to insufficient well recharge, well 7-D was analyzed only for total metals.

Two surface water samples were collected from the drainage ditch along the eastern boundary of the Sodium Plant; field measurements included pH, specific conductance, and temperature. Surface water samples were analyzed for CN and total metals including As, Ba, Cd, Cr, Cu, Pb, Hg, Ni, Se, Ag, and Zn.

Four sediment samples were collected both on site, in the vicinity of previous surface water samples, and off site between the RMI wastewater treatment ponds and the off site coal pile. Sediment samples were analyzed for CN, As, Ba, Cd, Cr, Cu, Pb, Hg, Ni, Se, Ag, and Zn.

Three staff gauges were installed in the off site drainage ditch to measure surface water elevations, which were used in conjunction with groundwater and surface water elevations to define the relationship between the shallow groundwater and surface water in the area.

The locations of all media sampled are provided in the Supplemental Investigation report as shown in Figure 1-1.

1.3.2 Conclusions of the Supplemental Investigation

Based upon this supplemental investigation for the RFI at the RMI Sodium Plant in Ashtabula, Ohio, the following conclusions have been made:

- The bedrock groundwater piezometric surface is mounded near the eastern boundary of the Sodium Plant site in response to the potentiometric head generated by the large volume of water potentially contained within the off-site coal pile. The development of the piezometric mound indicates that the bedrock water-bearing unit behaves as a semi-confining unit under these localized conditions. In addition, observations indicated that there is a net upward vertical gradient between the bedrock and shallow groundwater in the vicinity of the wastewater treatment ponds. The overall direction of bedrock groundwater flow is to the north towards Lake Erie and is locally influenced by the coal pile.

- The shallow drainage ditch off site and parallel to the eastern RMI property boundary flows both to the north and south with the flow divide located in the vicinity of stream gauge SG-18, and recharges the shallow groundwater. A potential source of this water is broken water piping from the Ashco (water supply) Reservoir.

- The shallow groundwater is mounded around the five wastewater treatment ponds and is recharged to the east by the drainage ditch nearest to the site. Due to the large storage capacity of water within the coal pile, the groundwater level is probably quite elevated within the coal pile. The shallow ditch nearest to the site appears to act to some degree as a groundwater divide between RMI property and the coal pile.

- Barium concentrations in the bedrock groundwater are very similar to those previously documented, with the exception of groundwater from well 9-D, and there is no migration of Ba believed to be off site east of the Sodium Plant. The Ba concentration in well 9-D was greater than three times higher than had been measured during the previous sampling episodes and this may be related to matrix interferences or variability inherent in the analytical methodology.

- Literature on barium concentrations in the Chagrin Shale provide information that supports the conclusion that Ba in the bedrock underlying the RMI site is likely to be naturally occurring.

- Cadmium concentrations in the shallow groundwater have decreased considerably across the site since the previous samples were collected during the original RFI investigation and the migration of Cd off site is unlikely.

- Elevated levels of Cd, Cr, Ni, and Zn were detected in off-site well 12-S. These elevated levels of inorganics appear to be the result of low pH groundwater generated by the off-site coal pile rather than migration of constituents from RMI property.

- The inorganics found in the off-site ditch water in detectable concentrations are at relatively low levels.

- The inorganics found in the off-site ditch sediments are at concentrations similar to those detected in the on-site ditch sediments, with the exception of significantly lower barium concentrations off site. The sediment inorganic concentrations combined with low levels of inorganics in the surface water indicate that inorganics are strongly sorbed onto the sediments.

- The Ba and Cd detected in the on-site ditch sediments most likely reflect the result of erosion of surficial soils in the adjacent disposal area (Area B).

- A comparison to the action levels proposed by the USEPA indicated the following:

  - None of the proposed groundwater action levels are considered relevant because RMI has demonstrated that the shallow water-bearing zone is characterized by a low yield and because of the absence of human receptors in the vicinity of the RMI Sodium Plant. For these reasons and due to the abundant surface water supply, it is not expected that the shallow water-bearing formation would be used as a drinking water source. In addition, it was determined that it is not likely that deep bedrock groundwater has been affected by Sodium Plant activities.

  - The action level for Cd in surface water was not exceeded by the surface water samples collected from the off-site ditch during the supplemental investigation.

1.4 INTERIM CORRECTIVE MEASURES

Since the conclusion of the RFI, interim corrective measures have been conducted at the facility which include the placement of a topsoil cover and seeding at Area A.

1.5 SCOPE OF CMS

The development of action levels for constituents and media of interest at the site indicated the need for a corrective measure study. The general approach taken in performing this corrective measures study was to follow the guidelines presented in the "Scope of Work for a Corrective Measures Study at RMI-Sodium Plant" (Scope of Work), previously issued by the USEPA. Utilizing this guidance, a draft site-specific CMS Plan was developed and submitted to the USEPA on May 15, 1991. In response to comments from the USEPA, the CMS Plan was revised and submitted on August 19, 1991 and again on March 10, 1993. The CMS Plan focused on the site areas and media of interest previously identified by the RFI, the revised HEA, and the Supplemental Investigation to the RFI. Through the use of the previous investigation and studies, specific site areas and preliminary corrective measure technologies to be evaluated by the CMS were presented.

To summarize, site specific areas and media specified in the CMS Plan to be addressed in the CMS based on USEPA action levels were as follows.

- Shallow/Near Subsurface Soils

  Area B: Cd, Pb, and As in surficial soils; Cd in surface water in drainage ditch near Area B (DW-B)

  Area C: Pb and As in surficial soils

  Area D: Pb in shallow soils 3 to 6.5 feet deep

  Area F: Pb and As in surficial soils

  Area G: As and Pb in surficial soils; Cd and Pb in soils 0.5 to 3.3 feet deep

- Groundwater

  In the RFI report it was demonstrated that the uppermost water-bearing zone in the vicinity of the RMI Sodium Plant is characterized by low yield and, therefore, groundwater in this water-bearing zone is not expected to

serve as a drinking water source. The HEA demonstrated the absence of potential human receptors via the groundwater pathway. In addition, concentrations of constituents in shallow downgradient monitoring wells are generally below current drinking water MCLs. The potential carcinogenic risk estimate for ingestion of shallow groundwater was determined to be within the acceptable range of carcinogenic risks (1×10^{-4} to 1×10^{-6}) recommended by the USEPA for remediation of CERCLA sites and proposed for the basis of action levels and cleanup standards for RCRA sites. Similarly, the potential noncarcinogenic risk estimate was below the USEPA's acceptable limit of 1.0. Lastly, it was determined that it is not likely that deep bedrock groundwater has been affected by Sodium Plant activities. For these reasons and due to the abundant surface water supply, it is not expected that the shallow water-bearing zone would be used as a drinking water source. Therefore, proposed groundwater action levels will be addressed by establishing appropriate corrective action objectives for waste sources.

- Surface Water

  The presence of Cd above the action level will be addressed.

- Deep Soils

  Deep soils will be addressed from the standpoint of the potential for contribution to groundwater contamination. No action levels for deep soils were proposed. As discussed above, groundwater does not exceed cleanup levels and, consequently, no corrective measures specific to the remediation of deep soils is included in the CMS.

Considering the media and site areas to be addressed in conjunction with the USEPA action levels, the preliminary corrective action objectives set forth in the CMS Plan to be applied to site areas were as follows.

- Reduce the potential for transport of constituents present in sediment and water in drainage areas.

- Reduce erosion (via wind and water) and runoff of site constituents from former site disposal areas.

- Reduce infiltration of former site disposal areas by incident precipitation.

- Reduce the potential for future groundwater contamination from constituents present in identified SWMUs.

- Reduce the potential for future exposure to groundwater contamination by on-site or off-site human receptors.

- Reduce the potential for future groundwater contamination from constituents present in identified SWMUs by reducing waste sources.

Based on this determination of site media and areas which must be addressed, corrective measures were to be identified and screened by a four step process, as follows.

- Identification of general response actions (based on the Corrective Action Objectives) appropriate to the environmental conditions at the site and to individual site areas.

- Identification of potential corrective measure technologies.

- Preliminary screening of potential corrective measure technologies.

- Selection of corrective measure technologies.

Since it was determined that soils at limited depths containing constituents above action levels are the primary concern at the RMI site, it was anticipated by the CMS Plan that the identification and screening of potentially applicable technologies for this site would be relatively straightforward and will not require an extensive evaluation of remedial alternatives.

It was with this site specific approach and other general requirements of the CMS Plan that this CMS has been completed.

2.0 REVISED HEALTH AND ENVIRONMENTAL ASSESSMENT

The Health and Environmental Assessment (HEA) was originally submitted to the USEPA as part of the RCRA Facility Investigation (RFI). On the recommendation of the USEPA and consistent with proposed 40 CFR 264 Subpart S, the HEA was removed from the RFI to be inserted in this Corrective Measures Study (CMS). The HEA was revised to reflect the USEPA comments as discussed in the May 1990 meeting and was resubmitted to the USEPA in the June 1990 Draft CMS (Partial Submittal). Section 2.0 is largely identical to the June 1990 HEA. Some modifications have been made to incorporate the findings of the Supplemental Investigation. At the request of the USEPA, Section 2.6, Risk Assessment for Ingestion of Shallow Groundwater, has been added.

The objective of the health and environmental assessment (HEA) is to integrate the findings of the RFI and assess the potential for release of site constituents and subsequent potential exposure of human and environmental receptors. The result of this assessment generally determines the significance of the known or potential releases from the facility being investigated, and guides the Agency in deciding whether interim corrective measures or a corrective measures study at the facility will be necessary. Interim corrective measures may be determined necessary if imminent endangerment to human health and/or the environment is expected. This revised HEA draws heavily on the information, data, figures, etc. of the Revised RFI report (ECKENFELDER INC.®, 1990) as well as the revised "Supplemental Investigation Report for the RCRA Facility Investigation RMI Sodium Plant, Ashtabula, Ohio" (Revised Supplemental Investigation report; ECKENFELDER INC.®, 1991).

The HEA process, as described in the current RFI guidance (USEPA, 1989a), is intended to be an expedited exposure assessment; the level of detail is dictated by the extent of information generated during the RFI. The approach taken for conducting the HEA is intended to be flexible, allowing for site-specific interpretation of release characterization data.

Basically, the HEA process consists of two components: (1) the identification of potential receptors and likely exposure routes; and (2) the comparison of measured (or in some cases, predicted) constituent concentrations in various media developed

in the release characterization of the RFI to chronic exposure limit criteria. The exposure limit criteria may be derived from several sources, and are applied, as appropriate, to exposure pathways of concern. For example, if a site was found to have the potential for release of constituents to groundwater, and local populations depended upon groundwater wells as a drinking water supply, comparison of groundwater concentrations at a point of exposure with the Safe Drinking Water Act Maximum Contaminant Levels (MCLs) would be appropriate. In other cases, it may be appropriate to compare measured concentrations to toxicity-based exposure limits assuming "acceptable" risk levels. Ambient Water Quality Criteria (AWQC) may also be selected as appropriate criteria for comparison if a release to surface water is predicted and aquatic biota are potentially exposed. It should be noted that the exposure limit criteria do not necessarily represent target clean-up levels, but are a means by which the Agency can evaluate the significance of a potential release.

In order to assess potential exposure of human or environmental receptors, an exposure pathway must be "complete". Complete exposure pathways are those which have all of the following components: a source(s) and mechanism of release (e.g., volatilization of organics from a waste impoundment); an environmental transport medium (i.e., air, soil, water); receptors and an exposure point (e.g., local populations using well water); and an exposure route (i.e., inhalation, ingestion, or dermal contact). If any of these components are absent, exposure does not occur. Therefore, in the comparison of site constituent concentrations with exposure limit criteria as required in the HEA process, only "complete" pathways will be evaluated.

The revised HEA for the RMI Sodium Plant, as presented in this section, will rely heavily on the information generated during the RFI and the Supplemental Investigation, as mentioned previously. As discussed in detail in the Revised RFI report, both inorganic and organic constituents have been detected at the site; however, organic contamination originates off site (see Section 6.6 of the Revised RFI report). Therefore, only inorganic constituents will be evaluated in the revised HEA. For each environmental medium (groundwater, soil, surface water, and air), the following will be discussed:

- Potential sources and measured concentrations
- Potential for release and migration

- Potential receptors
- Comparison with appropriate criteria
- Assessment of potential for exposure

In addition to the revised HEA, a baseline risk assessment was performed as required by the USEPA in comments on the March 1993 version of the Final CMS. The baseline risk assessment was performed on soils for the constituents, depths, and areas of interest resulting from a comparison of site soil data to background levels, as well as a comparison of USEPA action levels for the site. Exposure scenarios evaluated included both current (industrial worker population) and future (industrial and residential populations) scenarios. Although RMI considers future residential development of the site to be unlikely, the USEPA required that it be evaluated. The baseline risk assessment is support of the revised HEA. None of the total estimated carcinogenic risks for either the current or future scenarios exceeded the upper limit of USEPA's acceptable range (1×10^{-4}). Two future noncarcinogenic hazard indices exceeded USEPA's acceptable limit of 1.0 (both associated with Area B and the speculative future residential scenario); all of the other were below 1.0. When considered in conjunction with risk estimates from background soils, it is apparent that corrective measures for SWMUs other than Area B would only marginally enhance the protection of human health.

2.1 GROUNDWATER PATHWAY

2.1.1 Potential Sources and Concentrations

As described previously in Sections 4.1, 4.2, and 6.1 of the Revised RFI report, groundwater in the vicinity of the RMI Sodium Plant has been found to occur in two zones: an unconfined water table zone within the glacial till, with low to moderate hydraulic conductivity; and a deeper, confined water-bearing zone within a low hydraulic conductivity shale bedrock. The water table surface is estimated to occur at depths ranging from the ground surface to approximately seven feet deep within the weathered glacial till. Weathered glacial till extends from the ground surface to approximately 13 feet; it is underlain by a zone of unweathered till from 31 to 48 feet thick, and below that is the low hydraulic conductivity shale bedrock. The shallow unconfined zone receives recharge predominantly through precipitation, and thus is much more sensitive to seasonal variations than the deeper, confined zone. Also,

because of the low hydraulic conductivity of the till, yields for wells are very low. Because of the low hydraulic conductivity and thickness of the unweathered glacial till and the relatively high bedrock piezometric surface, it is believed that only a minimal hydraulic connection exists between the two zones (see Section 4.2.2 of the Revised RFI report). In fact, recent observations indicate that there is now a net upward vertical gradient between the bedrock and shallow groundwater in the vicinity of the wastewater treatment ponds (see Section 4.3.1 of the Supplemental Investigation report). In light of these factors, it is unlikely that an aquifer in the bedrock zone would be affected by any of RMI's current activities; therefore, groundwater in the bedrock zone will not be evaluated in the revised HEA.

Ten monitoring wells (wells 1-S through 10-S) were installed in the water table zone and were sampled twice (on November 16 through 18, 1988 and January 11 through 13, 1989) in support of the RFI (see Figure 1-1). All samples were analyzed for dissolved inorganics, with the exception of those collected from wells 1-S and 2-S which were not analyzed due the presence of a dense non-aqueous phase liquid (DNAPL) migrating from off of RMI property. Three additional wells, also shown on Figure 1-1, were installed during the Supplemental Investigation: wells 12-S and 13-S (installed on adjacent property between the RMI wastewater treatment ponds and the off-site coal pile) and well 8-SR (replacement well for previously abandoned well 8-S). During the sampling event which took place during the Supplemental Investigation (February 28 through March 2, 1991), all new and existing wells were sampled and analyzed for total and dissolved inorganics, with the exception of wells 1-S and 2-S (due to the presence of DNAPL) and well 8-SR (the well was dry and had not recharged with groundwater at the time of sampling). As discussed in Section 4.3.1 of the Revised Supplemental Investigation report, differences between total and dissolved inorganic concentrations measured were insignificant and may be indicative of the degree of well development conducted and/or may indicate analytical variability. For these reasons, and because dissolved inorganic data are available for all sampling events, for the purposes of discussion, the values for dissolved inorganics will be used.

Table 2-1 shows a summary of the maximum dissolved concentrations of inorganic constituents in shallow groundwater measured during the sampling events described above, as well as maximum concentrations of dissolved inorganics in shallow background wells (see Table 4-4 of the Revised Supplemental Investigation

TABLE 2-1

MAXIMUM CONCENTRATIONS OF INORGANIC CONSTITUENTS
AND FREQUENCY OF DETECTION IN SHALLOW GROUNDWATER[a]

Constituent (Detection Limit)	No. Times Detected Above Bkg/ No. Times Analyzed[b]	Maximum Concentration in Shallow Groundwater (ppb) [c]						
		Background[d] (Wells 9-S and 10-S)	Well 3-S	Well 4-S	Well 5-S	Well 6-S	Well 7-S	Well 8-S
Arsenic (5.0)	0/18	BMDL[e]	BMDL	BMDL	BMDL	BMDL	BMDL	BMDL
Barium (200-500)	14/18	BMDL	1,200	830	610	1,500	BMDL	1,900
Cadmium (1.0)	18/18	1.3	4.0	14.3	9.7	25.7	8.3	11.7
Chromium (2.0-5.0)	1/18	13.6	9.8	14.5	9.8	BMDL	5.9	13.0
Lead (3.0-10.0)	0/18	BMDL	BMDL	BMDL	BMDL	BMDL	BMDL	BMDL
Mercury (0.2-0.4)	2/18	BMDL	BMDL	0.6	BMDL	0.4	BMDL	BMDL
Selenium (1.0-5.0)	4/18	BMDL	1.1	1.5	BMDL	3.7	BMDL	BMDL
Silver (20.0-30.0)	0/18	BMDL	BMDL	BMDL	BMDL	BMDL	BMDL	BMDL

TABLE 2-1 (Continued)

MAXIMUM CONCENTRATIONS OF INORGANIC CONSTITUENTS
AND FREQUENCY OF DETECTION IN SHALLOW GROUNDWATER[a]

Constituent (Detection Limit)	No. Times Detected Above Bkg/ No. Times Analyzed[b]	Maximum Concentration in Shallow Groundwater (ppb) [c]						
		Background[d] (Wells 9-S and 10-S)	Well 3-S	Well 4-S	Well 5-S	Well 6-S	Well 7-S	Well 8-S
Copper[f] (20.0)	0/5	40	BMDL	BMDL	BMDL	BMDL	BMDL	--
Zinc[f] (15.0)	1/5	42	41	32	36	111	39	--
Nickel[f] (2.0)	2/5	20.6	10.8	15.5	28.6	71.6	12.7	--
Cyanide[f] (20.0)	1/5	BMDL	30.0	BMDL	BMDL	BMDL	BMDL	--

[a]From sampling events on 11/16/88 to 11/18/88, 1/11/89 to 1/13/89, and 2/28/91 to 3/2/91. Wells 1-S and 2-S not analyzed due to presence of DNAPL; well 8-SR not sampled because of no recovery at time of sampling; data for wells 12-S and 13-S not included because wells are located off site and may be influenced by coal pile located to the east of the site.

[b]Includes duplicates.

[c]Wells 3-S and 4-S are located on the eastern and northwestern boundaries of the closed landfill, respectively; wells 5-S and 6-S are located east of the wastewater treatment ponds (see Figures 6-1 and 6-2 of the Revised RFI report).

[d]The higher of measured values for well 9-S or well 10-S is given.

[e]BMDL = Below method detection limits.

[f]Analyzed for only during the 2/28/91 to 3/2/91 sampling event.

report). Data for wells 1-S, 2-S, and 8-SR are not included in this summary table for the reasons discussed above. Data for wells 12-S and 13-S are also not included in Table 2-1 because these wells are located outside of RMI property and are isolated from the RMI site by a groundwater divide; in addition, groundwater quality in well 12-S is believed to be influenced by the coal pile located to the east of the site. (see Section 4.3.1 of the Revised Supplemental Investigation report).

Also included in Table 2-1 is a ratio of the frequency of detection of a parameter above background concentrations (i.e., concentrations measured in wells 9-S and 10-S). As shown in Table 2-1 (and previously discussed in Section 6.1 of the Revised RFI report and Section 4.3.1 of the Revised Supplemental Investigation report), Ba and Cd were the only site constituents consistently detected well above background values in the shallow groundwater (14 of 18 analyses and 18 of 18 analyses, respectively). The highest concentration of Ba in shallow groundwater was found in well 8-S (1,900 ppb) which is located near the fill area north of the wastewater treatment ponds (Area G). The isoconcentration map for Ba in shallow groundwater (see Figure 6-1 of the Revised RFI report) indicates elevated concentrations of Ba in the area north and east of the wastewater treatment ponds, and due east of the closed landfill to a much more limited extent (Area A).

The highest Cd concentration in shallow groundwater was 25.7 ppb, measured in well 6-S, which is located east of the wastewater treatment ponds (Area D). The isoconcentration map for Cd in groundwater (see Figure 6-2 of the Revised RFI report) closely resembles the map for Ba. The major differences in the distribution of Ba and Cd in shallow groundwater is that the presence of Cd is indicated over a larger area, particularly extending north and west; and that presence of Cd near the closed landfill is shown to exist in an isolated area near the northwest corner of the landfill, rather than to the east.

2.1.2 Potential for Release and Migration

The only potential migration pathways of site constituents in shallow groundwater to other media are: the potential discharge of groundwater into on-site surface water ditches; and potential discharge of shallow groundwater to groundwater in the deeper bedrock zone. The potential for release of site constituents via these pathways is discussed below.

The occurrence of elevated levels of Ba and Cd in shallow groundwater in the fill areas in the vicinity and north of the wastewater treatment ponds, and at northwest and east perimeters of the closed landfill is consistent with what is known about the placement of wastes in those areas, i.e., they were fill areas which received wastes containing primarily Ba, Cd, and Pb (see Section 5.2 of the Revised RFI report). However, the concentrations of Ba and Cd are generally higher north and east of the wastewater treatment ponds (Area D and G, wells 6-S and 8-S) compared to concentrations at the landfill perimeter (Area A, wells 3-S and 4-S). The concentrations of Ba and Cd in shallow groundwater in Areas D and G may be due to the leaching of waste materials in the fill areas near the wastewater treatment ponds, and/or may be due, in part, to recharge of the groundwater from the wastewater treatment ponds. These potential migration pathways will be further discussed in Sections 2.2.2 and 2.3.2, respectively. Although the closed landfill was also a fill area, it is believed that the lower concentrations of Ba and Cd in the subsurface soils and in groundwater are indicative of the fact that less "concentrated" wastes were placed there, and at lesser depths than Areas D and G (see Section 5.2 of the Revised RFI report).

Regionally groundwater flow is expected to be northward toward Lake Erie. Locally, groundwater flow is generally toward rivers and tributaries. As discussed in Section 4.2.2 of the Revised RFI report, the direction of groundwater flow in the glacial till (shallow or water table zone) in the vicinity of the Sodium Plant is highly variable due to the hydraulic influence of the seven ponds on site. As was shown in Figure 4-11 of the Revised RFI report, in general, groundwater is mounded around the wastewater treatment ponds, and the overall groundwater flow radiates outward from the site.

However, as will be further discussed in Section 2.3.1.2, Ba has not been detected in on-site ditch water samples and Cd has either not been detected or is present only at relatively low levels, with the exception of one sample (DW-B), which is believed to be present due to erosion of localized surficial soil. Groundwater is believed to discharge to some extent to the on-site drainage ditches. As discussed in Section 4.2 of the Revised Supplemental Investigation report, the drainage ditch east of the wastewater treatment ponds actually recharges the shallow groundwater, as indicated by groundwater elevations which are lower than surface water elevations

on both sides of the ditch (see Figures 4-1 and 3-2 of the Revised Supplemental Investigation report). This drainage ditch appears to act as a shallow groundwater divide between the groundwater beneath the ponds on the site and the groundwater beneath the coal pile located off site to the east, and the off-site migration of constituents in groundwater to the east of the RMI Sodium Plant site is not occurring. Surface water recharge to shallow groundwater will be further discussed in Section 2.3.2.

Groundwater south and west of the wastewater treatment ponds appears to partially discharge to the drainage ditch which flows around the perimeter of the closed landfill, off the RMI Plant property to the southwest (i.e., the DS Tributary). Assuming the same average saturated thickness of 11 feet, but a much smaller horizontal hydraulic gradient, a discharge rate for this area has been estimated at 0.05 gal/day per linear foot (see Section 4.2.2 of the Revised RFI report). Therefore, groundwater is expected to discharge, in some areas, to on-site surface water. However, because the drainage ditches are shallow, and may not intercept the entire water table zone, contribution of constituents from groundwater to on-site surface water is expected to be minimal. In addition, the flow lines for shallow groundwater as shown in Figure 4-11 of the Revised RFI report indicate that the surface drainage area to the south and west of the closed landfill acts somewhat as a groundwater divide, with on-site and off-site groundwater converging at that point, presumably serving to restrict groundwater from flowing off site southwest of the site. Because no piezometers or wells are installed on the south side of the ditch, groundwater flow in this area cannot be completely evaluated.

As previously discussed in Section 2.1.1, hydraulic conductivity data and hydraulic gradient data indicate that negligible groundwater discharge is expected to occur from the water table zone to the lower shale bedrock rock zone. As discussed in Section 4.3.1 of the Revised Supplemental Investigation report, Ba was the only inorganic constituent consistently detected in the bedrock groundwater and it occurred in concentrations significantly greater than the shallow groundwater concentrations. However, these concentrations of Ba are believed to be naturally-occurring as Ba concentrations in the Chagrin Shale in southern Ohio are known to be naturally elevated. In addition, major ion data indicate that Ba in the deep groundwater could not have originated from the shallow aquifer, but rather, is naturally-occurring or from an off-site source.

2.1.3 Potential Receptors

As discussed in Section 4.1.4 of the Revised RFI report, the till and bedrock in the vicinity of the RMI site are characterized by low yields. Except for the City of Orwell located in far southwestern Ashtabula County (about 15 miles from the RMI Sodium Plant), all of the municipalities in the area utilize Lake Erie or reservoirs as public water supply sources (see Section 4.1.4 of the Revised RFI report). The source of water for the City of Orwell is groundwater.

Because of low groundwater yields and abundant surface water supplies, there are few domestic wells and no municipal wells in the area. There are no domestic or municipal wells screened in the shallow groundwater unit. There are no springs used as a source of drinking water. There are nine domestic wells within a 5 km radius of the RMI Sodium Plant (see Figure 4-5 of the Revised RFI report); all except one are located south of the Sodium Plant upgradient of the site, and generally yield less than 5 gpm. Figure 2-1 shows the locations of eight of these wells along with the residences nearest the RMI Sodium Plant. All of these wells are screened in the lower bedrock water-bearing zone (see Section 4.1.4 of the Revised RFI report). One domestic well is located northeast of the plant, approximately 3.8 km away. This well is approximately 200 feet deep and yields less than 0.1 gpm. However, personnel at the Ohio Department of Natural Resources believe that it is highly unlikely that the well is a source of drinking water because of low yield, and because wells in the area over 150 feet deep are usually brackish (see Section 4.1.4 of the Revised RFI report).

In Section 4.1.4 of the Revised RFI report, it was demonstrated that the uppermost water-bearing zone (or that in the glacial till deposits) in the vicinity of the RMI Sodium Plant is characterized by low hydraulic conductivity and, subsequently, low yield, therefore, groundwater in this water-bearing zone is not expected to serve as a source of drinking water.

In summary, this investigation has determined that there are no potential human receptors of shallow groundwater in the vicinity of the RMI Sodium Plant. No environmental receptors were identified, except those which may exist in surface